

**FEEDING ON LARVAE OF *DANAUS PLEXIPPUS* (L.)
(LEPIDOPTERA: NYMPHALIDAE) CAUSES MORTALITY IN THE
ASSASSIN BUG *PRISTHESANCUS PLAGIENNIS* WALKER
(HEMIPTERA: REDUVIIDAE)**

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Abstract

Adult and nymphal assassin bugs, *Pristhesancus plagipennis* Walker, fed second/third instar larvae of *Danaus plexippus* (L.) died after ca 20 and 11 days respectively, after consuming 34.4 larvae (adults) or 10.6 larvae (nymphs). No bugs died when fed on mealworm *Tenebrio molitor* (L.) larvae. It is concluded that cardiac glycosides sequestered by *D. plexippus* larvae from its milkweed host plant, *Asclepias fruticosa* (L.), were progressively accumulated within *P. plagipennis*, resulting in bug mortality.

Introduction

Pristhesancus plagipennis Walker is a large (2-2.5 cm), common Australian assassin bug that is an important generalist predator of a number of insect pests of citrus and other crops in northern New South Wales and Queensland. In citrus it feeds on caterpillars, stink bugs, mealybugs, aphids, beetles and katydids (Smith *et al.* 1997). James (1994) showed *P. plagipennis* consumed up to 154 prey items during development and the long lived adults (James 1992) consume 1-2 prey daily (James, unpubl. obs.).

Field and laboratory observations indicate that *P. plagipennis* readily attacks and feeds on larvae of the monarch or wanderer butterfly, *Danaus plexippus* (L.). *D. plexippus* is an aposematic species which sequesters cardiac glycosides from its milkweed (Asclepiadaceae) foodplants as a defence against vertebrate predators (Reichstein *et al.* 1968, Brower 1969). The ecology of vertebrate predation on adult *D. plexippus* and palatability has been extensively studied in North America and Mexico (Malcolm 1991, Wells and Wells 1992 and references therein). However, relatively little attention has been paid to the impact of invertebrate predation on *D. plexippus* adults or larvae, despite evidence it may occur at significant levels in some habitats. For example, yellowjacket wasps *Vespa vulgaris* (L.) and the dragonfly *Hagenius brevistylus* Selys have been recorded preying on adult *D. plexippus* (Leong *et al.* 1990, White and Sexton 1989). Urquhart (1960), Smithers (1973) and Zalucki and Kitching (1982) reported lacewing larvae, ants, spiders, predatory bugs (Pentatomidae, Reduviidae), sphecid wasps, cockroaches, ladybirds and mantids, as confirmed or potential predators of *D. plexippus* larvae. Although the cardiac glycosides sequestered by *D. plexippus* are vertebrate 'heart poisons', they have the potential to be toxic to invertebrates which have not developed a detoxification mechanism (Whittaker and Feeny 1971). Oleander aphids

Aphis nerii Boyer de Fonscolombe reared on milkweed, caused disruption to predatory behaviour and web building when fed to spiders, but did not cause mortality. There are no published studies of adverse impacts on invertebrate predators caused by feeding on *D. plexippus*.

This study describes apparent cardiac glycoside-induced mortality of *P. plagipennis* when provided with a diet of *D. plexippus* larvae.

Materials and Methods

Pristhesancus plagipennis used in this study were obtained from laboratory colonies initiated from adult bugs collected in southern Queensland and maintained at the Yanco Agricultural Institute in southern New South Wales, where the experiments were conducted. *D. plexippus* larvae were reared on *Asclepias fruticosa* (L.) from eggs laid in captivity at Yanco by butterflies collected in Sydney (1990) or southern Queensland (1998).

Experiment 1 (1990)

Twelve second instar, 12 fourth instar and 12 adult *P. plagipennis* were caged separately in plastic cups (10 cm diameter) with muslin lids and held at $25 \pm 1^\circ \text{C}$ under a 15 h photophase. Commencing on 12 June, half of each cohort was provided with larvae of *D. plexippus* as prey. Adult bugs (three males, three females) were fed three second or third instar larvae and nymphs were fed two larvae daily. A few leaves of *A. fruticosa* were supplied as food for the larvae. The remaining six bugs in each cohort were each supplied with three mealworm *Tenebrio molitor* L. larvae daily. All bugs were fed on a diet of mealworms and *Drosophila* sp. prior to the experiment. The number of consumed *D. plexippus* and *T. molitor* larvae was recorded for each bug and carcasses removed daily. No other food was provided. The longevity of each bug was recorded.

Experiment 2 (1998)

Following the same protocol as Experiment 1, six third instar nymphs of *P. plagipennis* were provided with one to three third instar larvae of *D. plexippus* daily, commencing on 7 October. Six third instar nymphs were provided with two mealworm larvae daily. Prey consumed and bug longevity were recorded for each bug.

Results

All bugs fed larvae of *D. plexippus* in the two experiments died after mean periods of 20.2 ± 1.2 (adults) and 10.6 ± 0.7 days (nymph data combined) (Table 1). Adults consumed an average 34.4 ± 1.9 larvae before dying, whilst nymphs (combined data) consumed an average of 10 ± 2 larvae (Table 1). There was no apparent diminution in the propensity of *P. plagipennis* to feed on *D. plexippus* larvae during the experiments. No adult or nymph of *P. plagipennis* died during these experiments when fed on mealworm larvae.

Table 1. Longevity and prey consumption by *P. plagipennis* when fed second/third instar larvae of *D. plexippus*. No mortality occurred in corresponding cohorts of *P. plagipennis* fed larvae of *T. molitor*.

Stage of <i>P. plagipennis</i> (n)	Mean ($\pm$ SE) longevity (days)	Mean ($\pm$ SE) number of <i>D. plexippus</i> larvae consumed
<i>Experiment 1</i>		
Second instar (6)	10.8 (0.9)	10.6 (0.8)
Fourth instar (6)	12.0 (1.5)	11.0 (1.8)
Adult (6)	20.2 (1.2)	34.4 (1.9)
<i>Experiment 2</i>		
Third instar (6)	9.0 (1.0)	8.7 (0.6)

Discussion

These results indicate that *D. plexippus* larvae are toxic to *P. plagipennis*. Oyeyele and Zalucki (1990) recorded cardiac glycoside levels of 119-719 $\mu\text{g}/0.1\text{ g}$ (mean = 345 $\mu\text{g}/0.1\text{ g}$) of plant material dry weight (DW) in *A. fruticosa*. *D. plexippus* larvae feeding on this milkweed would therefore contain significant concentrations of cardiac glycosides. Thus, it is likely that the mortality of *P. plagipennis* in these experiments can be attributed to progressive cardiac glycoside poisoning.

Adult *P. plagipennis* took about three weeks to die when fed on a diet of *D. plexippus* larvae, whilst nymphs succumbed in half this time. Therefore it is unlikely that occasional predation of *D. plexippus* larvae by *P. plagipennis* would affect field survival of this predator. Presumably, utilisation by *P. plagipennis* of a mixed diet (as is normal for this generalist predator) would minimise the adverse effects of consuming an occasional larva of *D. plexippus*. Further, it is possible under natural conditions that *P. plagipennis* would avoid or reject *D. plexippus* larvae as prey, after feeding experience.

The significance of this study is that cardiac glycoside sequestration in *D. plexippus* has the potential to provide chemical defence against invertebrate as well as vertebrate predators. However, this would only occur if invertebrate predators 'learned' to reject or avoid *D. plexippus* larvae. Further research should be aimed at determining whether this can occur under natural conditions. In this study, *P. plagipennis* had no choice but to feed on *D. plexippus* larvae; the provision of choice between toxic and non-toxic foods might allow the development of avoidance or rejection behaviours. Cardiac glycoside-based defence is likely to work best against generalist invertebrate predators with no specific detoxification mechanisms (Bernays and Cornelius 1989). Thus, the reported predators of *D. plexippus* larvae (e.g. stink bugs, spiders, mantids, lacewings and ladybirds) are all likely to be susceptible to cardiac glycoside poisoning, if a sufficient number of larvae are eaten. In the case of ants, *D. plexippus* larvae would be shared

between many individuals, thus preventing or minimising toxicity to individual ants. Cardiac glycoside poisoning of invertebrate predators of larval *D. plexippus* may be more acute on some North American and Mexican milkweeds which contain greater concentrations of cardiac glycosides than *A. fruticosa* (e.g. *Asclepias linaria* (L.) contains an average 3369 µg/0.1 g DW: Zalucki *et al.* 1990).

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